REMARKS

The present application was filed on October 31, 2001 with claims 1-41. New claims 42 and 43 have been added by the present Amendment. Claims 1-43 remain pending. Claims 1-3, 13, 22, 29, 32-34, 39, 42 and 43 are the pending independent claims.

In the outstanding Office Action dated February 25, 2003, the Examiner: (i) rejected claims 1-33 under 35 U.S.C. §112, second paragraph, as being indefinite; (ii) rejected claims 1 and 2 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,514,974 (hereinafter "Bouldin"); (iii) rejected claims 3, 8, 10-12, 29 and 31 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,900,735 (hereinafter "Yamamoto"); (iv) rejected claims 4-7, 9 and 30 under 35 U.S.C. §103(a) as being unpatentable over Yamamoto in view of a 1991 IEEE article by Hoang et al. (hereinafter "Hoang"); (v) rejected claims 13-28 under 35 U.S.C. §103(a) as being unpatentable over Yamamoto in view of U.S. Patent No. 5,049,811 (hereinafter "Dreyer"); (vi) rejected claims 34-41 under §35 U.S.C. 103(a) as being unpatentable over the references cited for claims 1-33; and (vii) objected to the drawings.

In response to the Office Action, Applicants traverse the rejections to claims 1-41, amend claims 1 and 2, and add new claims 42 and 43.

With regard to the rejection of claims 1-33 under 35 U.S.C. §112, second paragraph, Applicant respectfully traverses. Regarding claims 11 and 24, "boustrophedon" is defined in Webster's dictionary as meaning "the writing of alternate lines in opposite directions (as from left to right and from right to left)" (Webster's Ninth New Collegiate Dictionary, Merriam-Webster Inc., 1991, p. 172). The term is therefore believed to be clear, and fully compliant with §112, second paragraph. Regarding the rejection of claims 1-33 for the use of the terms "test structure" and "test device," the terms "test structure" and "test device" are terms of art described throughout the specification (see, e.g., page 3, lines 7-27). The terms are also used by references cited in the Office Action (see, e.g., Bouldin). These terms are therefore believed to be clear, and fully compliant with §112, second paragraph.

With regard to the rejection of claims 1 and 2 under 35 U.S.C. §102(b) as being anticipated by Bouldin, Applicants assert that such claims are patentable. Bouldin discloses a test device and method for signaling metal failure of a semiconductor wafer. The test device includes a monitor

structure and a control structure, each having a plurality of metal segments. At least one metal segment of the monitor structure is prone to failure, while the segments of the control structure are resistant to failure. The monitor and control structures have equal resistance when there is no metal failure and a measurable difference upon metal failure.

Independent claims 1 and 2 were amended to more clearly set forth the present invention. Specifically, independent claims 1 and 2 were amended to clarify the structure and length of the stress migration test structure. Support for these amendments can be found, for example, in FIGS. 1 and 2 and on page 5, lines 4-19, of the specification. As set forth in claims 1 and 2 as amended, the stress migration test structure comprises a conductive runner having a length sufficient to develop axial stress above a threshold for nucleating voids. Further, the runner has a plurality of taps at uniform impedance intervals along the runner. A variation in impedance between adjacent taps indicates a stress migration void.

The method and system described in Bouldin fails to disclose a conductive runner meeting the above-noted limitations. As indicated above, Bouldin discloses a monitor structure and a control structure which have equal resistance in the absence of metal failure. Further, Bouldin does not specify a length of the full runner, but instead specifies the length of segments in the control and monitor structures. Finally, in the present invention a plurality of taps are spaced along the runner at uniform impedance intervals so that impedance at each interval may be determined and compared. This results in a more precise determination of the location of a resulting void. Bouldin discloses the comparison of the monitor and control structures to determine if a metal failure occurred. These distinguishing features are now recited in independent claims 1 and 2 of the present invention. Accordingly, withdrawal of the rejection to claims 1 and 2 under §102(b) is respectfully requested.

With regard to the rejection of claims 3, 8, 10-12, 29 and 31 under 35 U.S.C. §102(b) as being anticipated by Yamamoto, Applicants respectfully traverse on the ground that Yamamoto fails to teach or suggest the limitations of at least independent claims 3 and 29, from which claims 8, 10-12 and 31 directly depend. Yamamoto discloses a device for evaluating reliability of interconnect wires. The device includes a substrate, an insulating film over the substrate, and a hole chain formed in the insulating film. The hole chain has a plurality of holes electrically connected in sequential

order. The center-to-center distance between two adjacent holes is not less than a length x times a Blech length.

In contrast to the arrangement shown in Yamamoto, independent claims 3 and 29 disclose a stress migration test device, comprising a conductive runner having a length sufficient to develop axial stress above a threshold for nucleating voids. The runner has a plurality of taps at uniform impedance intervals along the runner. A variation of impedance between adjacent taps indicates the presence of a stress migration void in the runner.

Independent claims 3 and 29, thus differ from Yamamoto in that Yamamoto specifies the length of individual segments of a chain, while the present invention specifies a length of a full conductive runner. The conductive runner defined in claims 3 and 29 has a plurality of taps along the defined length, resulting in the ability to more precisely determine the location of a void. A plurality of taps does not exist along the length defined in Yamamoto. Instead, electrically connected holes are disposed at the ends of each segment. Accordingly, withdrawal of the rejection to claims 3, 8, 10-12, 29 and 31 under §102(b) is respectfully requested.

Regarding the rejection of claims 4-7, 9 and 30 under 35 U.S.C. §103(a) as being unpatentable over Yamamoto in view of Hoang, Applicants respectfully traverse on the ground that Yamamoto in view of Hoang fails to teach or suggest the limitations of at least independent claims 3 and 29, from which claims 4-7, 9 and 30 directly depend, for at least the reasons identified above with regard to claims 3 and 29.

Regarding the rejection of claims 13-28 under 35 U.S.C. §103(a) as being unpatentable over Yamamoto in view of Dreyer, Applicants respectfully traverse on the ground that Yamamoto in view of Dreyer fails to teach or suggest the limitations of at least independent claims 13 and 22, from which claims 14-21 and 23-28 directly or indirectly depend. Independent claims 13 and 22 disclose a chip having a stress migration test device, comprising a conductive runner having a length sufficient to develop axial stress above a threshold for nucleating voids. The runner has a plurality of taps at uniform impedance intervals along the runner. A variation of impedance between adjacent taps indicates the presence of a stress migration void in the runner.

Independent claims 13 and 22 differ from Yamamoto in that Yamamoto specifies the length of individual segments of a chain, while the present invention discloses a length of a full conductive

runner. The conductive runner defined by claims 13 and 22 has a plurality of taps along the defined length, resulting in the ability to more precisely determine the location of a void. A plurality of taps does not exist along the length defined in Yamamoto. Instead, electrically connected holes are disposed at the ends of each segment. Accordingly, withdrawal of the rejection to claims 13-28 under §103(a) is respectfully requested.

With respect to the rejection of claims 34-41 under 35 U.S.C. §103(a) as being unpatentable over the references rejecting claims 1-33, Applicants respectfully traverse on the ground that these references fail to teach or suggest the limitations of at least independent claims 34 and 39, from which claims 35-38, 40 and 41 directly or indirectly depend. Independent claims 34 and 39 disclose the step of fabricating a stress migration test device, comprising a conductive runner having a length sufficient to develop axial stress above a threshold for nucleating voids. The runner is provided with a plurality of taps at uniform impedance intervals along the runner. An impedance is calculated and normalized and a variation of impedance between adjacent taps indicates the presence of a stress migration void in the runner.

Independent claims 34 and 39 differ from the previously mentioned references in that the previously mentioned references specify the length of individual segments of a chain, while the present invention discloses the fabrication of a specific length of a full conductive runner. The conductive runner defined by claims 34 and 39 has a plurality of taps that are provided along the defined length, resulting in the ability to more precisely determine the location of a void. A plurality of taps does not exist along the length defined in the previously mentioned references. Accordingly, withdrawal of the rejection to claims 34-41 under §103(a) is respectfully requested.

It is noted that independent claims 32 and 33 were not rejected under §102 or §103, and should have been indicated as allowable subject matter in the Office Action.

New claims 42 and 43 were added. Claim 42 incorporates elements of claims 3 and 9. The references cited do not disclose parallel conductor paths of different impedances. Claim 43 incorporates elements of claims 3 and 11. The references cited do not disclose a conductive runner that serpentines boustrophedonically on a common plane.

FIG. 10 has been amended so that "Prior Art" is included in the legend. The specification has been amended to correct minor errors of a typographical nature. Attached hereto is a marked-up

version of the changes made to the specification and claims by the present Amendment. The attached pages are captioned "Version with Markings to Show Changes Made."

In view of the above, Applicants believe that claims 1-43 are in condition for allowance, and respectfully request withdrawal of the §112, §102(b), and §103(a) rejections.

Respectfully submitted,

Joseph B. Ryan

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Joseph B. Ryan
Attorney for Applicant(s)
Reg. No. 37,922
Ryan, Mason & Lewis, LLP
90 Forest Avenue
Locust Valley, NY 11560
(516) 759-7517

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

The paragraph beginning on page 7, line 6, and ending on page 8, line 2, has been amended as follows:

A combination of factors, not just the size of the metal runner alone, accounts for the ability of the stress migration test structure 10 to detect stress migration voids, and concomitantly permits an inference of the presence or absence of stress migration voids in other conductors similarly manufactured. The factors include the voltage across the resistance string, the voltage measurement resolution of the test hardware, the expected magnitude of impedance deviation from the ideal impedance expected in the presence of a stress migration void, the probability of finding a stress migration void in a length of metal runner between two adjacent taps, and the desired confidence that the resistor string is free of stress migration voids. A stress migration void can be detected by placing a tolerance on the measured impedance between any two adjacent taps of the stress migration test structure, as compared to an ideal expected impedance, or an average of the individual resistor impedances where the taps are uniformly spaced. The magnitude of the tolerance is one factor in determining the size of stress migration voids detected. The tolerance is determined empirically by determining the minimum stress migration void size for maintaining mechanical integrity of structural materials surrounding the void, by acceptable degradation in [electromigratioin] electromigration design rules, and by acceptable change in resistance according to electrical design consideration. Typically, 25 percent line width or cross-section penetration is the maximum allowable void size. The number of resistors, R_n, in the runner of stress migration test structure 10 is dependent on the probability of growing a void in any unit of runner length, which depends on the microstructure of the metal including the crystallographic grain size (local ordered arrangement or atoms, e.g., cubic symmetry, face-centered cubic, body-centered cubic, hexagonal, etc.) thickness of the metal, mechanical stress for barrier layer, anti-reflection coatings on top of runner, and modulus for dielectric coating overlying the metal runner.

The paragraph beginning on page 10, line 8, has been amended as follows:

Using the Kelvin sensing measurement technique described above, starting at one end of the stress migration test structure and using four taps, apply a known current between the outer two of four probes and measure the developed voltage between the two inner probes, then compute and store for subsequent processing the impedance of the second segment of the stress migration test structure. Note when using the Kelvin method, the first segment is unavailable for measurement. If the taps, where the probes will contact, are arranged in a pattern, an automated probe positioning tool can be used to step through the taps to measure the impedance of the segments of the stress migration test structure 10 or 210. [The] <u>To</u> step to a new group of taps, apply a current, measure the developed voltage, determining the impedance by application of Ohm's law, <u>and</u> store the impedance[,]<u>. This</u> technique is repeated until the impedance of all but the last segment of the stress migration test structure have been recorded. The last segment of the stress migration test structure is also unavailable for Kelvin measurement. The impedance of each of the segments of the stress migration test structure except the two end segments are known. The impedance of the first and last segments of the stress migration test structure may be ignored in subsequent calculations.

<u>IN THE CLAIMS</u>

The claims were amended as follows:

1. (Amended) A wafer, comprising:

at least two die areas formed on the wafer, the at least two die areas defining a street therebetween; and

a stress migration test structure in the street, the stress migration test structure [capable of detecting stress migration voids] <u>comprising a conductive runner having a length sufficient to develop axial stress above the threshold for nucleating voids for the technology in which the runner is fabricated, the conductive runner having a plurality of taps at uniform impedance intervals along the runner, the taps spaced along the runner such that the variation of the impedance of the runner between adjacent taps, due to the presence of a stress migration void in the runner is a detectable portion of the impedance between the adjacent taps absent stress migration voids</u>.

2. (Amended) A wafer, comprising:

at least four die areas formed on the wafer, the at least four die areas defining two intersecting streets thereamong; and

a stress migration test structure [capable of detecting stress migration voids, the stress migration test structure] in a region of the two intersecting streets proximate the at least four die areas <u>and comprising a conductive runner having a length sufficient to develop axial stress above the threshold for nucleating voids for the technology in which the runner is fabricated, the conductive runner having a plurality of taps at uniform impedance intervals along the runner, the taps spaced along the runner such that the variation of the impedance of the runner between adjacent taps, due to the presence of a stress migration void in the runner is a detectable portion of the impedance between the adjacent taps absent stress migration voids</u>.

--42. A stress migration test device, comprising:

a conductive runner, the conductive runner having a length sufficient to develop axial stress above a threshold for nucleating voids for a technology in which the runner is fabricated, wherein the conductive runner is comprised of two conductive materials providing parallel conduction paths of different impedances.

43. A stress migration test device, comprising:

a conductive runner, the conductive runner having a length sufficient to develop axial stress above a threshold for nucleating voids for a technology in which the runner is fabricated, wherein the conductive runner serpentines back and forth boustrophedonically on a common plane.--